A.2.16 MARS INSTRUMENT DEVELOPMENT PROJECT

1. Scope of Program

1.1 Overview

NASA's recently restructured Mars Exploration Program (MEP) calls for a series of highly ambitious missions over the next decade. The overall goals of the MEP must be achieved with relatively low mission risk and within tightly constrained cost resources. Information on NASA Mars programs may be obtained from the World-Wide Web at URL http://mars.jpl.nasa.gov/overview/index.html.

The Mars Smart Lander (MSL) mission will be the gateway mission to the first sample return mission, which will occur no earlier than 2011. The MSL mission is intended to push the state-of-the-art of *in situ* scientific observations of Mars, demonstrate several technologies critical to the follow-on Mars Sample Return (MSR) mission, and provide information vital for implementing the entire MEP. The MSL mission will take advantage of a rich legacy of remote sensing observations by targeting a preselected site of scientific interest. It will demonstrate precision landing technologies, carry a rover that will traverse a minimum of 6 km across the Martian surface, and explore the planet's subsurface for the first time. Additional background on rover testing and deployment may be obtained at URL http://robotics.jpl.nasa.gov/tasks/scirover/homepage.html. It is planned that the MSL mission will be launched in either the 2007 or 2009 Mars launch opportunities.

The first of NASA's new line of Mars Scout missions are also planned for launch in the 2007 launch opportunity, and to this end four Scout mission investigations were chose for Phase A studies in December 2002. Within the Mars Scout Project, investigation platforms may include airborne vehicles, small landers, and subsurface explorers. More information on the Mars Scout Project can be found at http://spacescience.nasa.gov/an/marsscoutsworkshop/

Such ambitious mission plans require that many new instruments be brought to a flight-ready status within a short time span and at low cost. While NASA's Planetary Instrument Definition and Development (PIDD) program (P; Appendix A.2.11 in this NRA) funds research to develop breadboard versions of new instruments, there is a critical gap in support between this demonstration phase and actual flight hardware construction. Such a gap increases the mission risk and development time of any proposed new instruments. Therefore, this Mars Instrument Development Project (MIDP) solicits proposals for research and development to take promising instruments that are specifically suited for the characterization of the Mars surface from the breadboard or laboratory-demonstration phase (as may have been developed through the PIDD program element A.2.11, for example) to a point where they can be tested in systems-level simulated rover or static lander operations or under similarly realistic (terrestrial environment) conditions.

The instruments to be supported under this MIDP solicitation must specifically target issues related to characterizing the Martian near-surface, surface, or near-subsurface environments from a lander or rover by conducting detailed *in situ* analytical studies of acquired materials (i.e., collected "samples"), or by mechanically acquiring (grabbing, coring, or chipping of rock and soil samples, or capturing and storing atmospheric samples) samples for analysis and/or caching for later return to Earth. For such applications, low volume, mass, and power consumption are a necessity, so the miniaturization of instruments and their supporting electronics is of great importance. Therefore, proposals that seek to combine existing instruments into architectures that lead to an overall reduction in size, mass, or power consumption are especially encouraged.

This MIDP solicitation, as advertised through this NRA, will only support instrument efforts that address the science needs of the Mars Scout missions, the Mars Smart Lander and subsequent missions planned for 2007-2011. Instrument development for the currently planned and approved Mars 2003 and 2005 missions will not be supported by this program element and should not be proposed.

The instruments proposed for further development through this MIDP must be at a moderately advanced ("breadboard") stage of development, consistent with current or past PIDD support, Sensor and Instruments Technology Development Program support, Small Business Innovative Research (SBIR) funding, and/or other documented research and development. Proposed instruments are not required to have past NASA program support but must demonstrate having completed development through a satisfactory breadboard proof-of-concept phase.

It is emphasized that any instrument development proposed in response to this solicitation must be justified by a brief but complete discussion of the type(s) of science investigations that could be carried out should the instrument be eventually selected for flight. Wherever possible, each proposal should contain specific reference to the specific NASA Space Science Enterprise goal, Solar System Exploration Theme objective, or MEP requirement that is supported by the proposed instrument technology development. Such scientific justification is the responsibility of the proposer and not for inference on the part of NASA or the peer reviewers of the submitted proposals.

Note that in order to enable the NASA Office of Space Science to properly evaluate the relevance of proposals submitted to its programs, as well as to track its progress towards achieving its goals as mandated by the Government Performance Review Act (GPRA), all research supported by NASA's programs must now demonstrate its relationship to NASA Goals and Research Focus Area's (RFA's) as stated in the latest version of its Strategic Plan (follow links from the Web site http://spacescience.nasa.gov/); see also the discussion in Section 1 of the *Summary of Solicitation* of this NRA. Therefore, all proposers to this program element are asked to state their perception of this relevance in terms of the Goals, Science Objectives, and RFA's given in Table 3 found in the *Summary of Solicitation*. In particular,

this program element is designed to help fulfill all of the RFA's for the Science Objectives 4, 5, and 6 for Goal II of the Solar System Exploration science theme. The appropriate place for this statement of relevancy is in the introduction to the proposal's "Scientific/Technical/Management" section (see Section 2.3.5 in the *Guidebook for Proposers*). The index numbers in this table may be used to identify a specific RFA, for example, "Goal I, Sun-Earth Connection Theme, RFA 1(c)" or "Goal II, Astronomical Search for Origins, RFA 3(b)."

Finally, proposals pertaining to the biological history of Mars and/or indicators of past and present life should be directed to the Astrobiology Science and Technology Instrument Development (ASTID) program in this NRA (program element A.2.13) or the Astrobiology Science and Technology for Exploring Planets (ASTEP) program that will be solicited through a future NASA Research Announcement.

1.2 Scientific Focus

Proposals for instrument development that address the following science objectives of the Mars Smart Lander mission will be considered for funding through this solicitation (in no particular priority order):

- To improve our understanding of the Mars climate through analysis of *in situ* materials;
- To increase our understanding of the availability and amount of water on Mars;
- To identify areas and materials of possible interest for future scientific exploration (both *in situ* and via sample return);
- To determine the nature of surface geological processes from surface morphology and chemistry, including the characteristics of sub-micrometer scale features;
- To determine the spatial distribution and composition of minerals, rocks, soils, and ices on and within the accessible Martian surface;
- To investigate properties of the Martian near subsurface; and
- To improve our knowledge of the deep Martian interior.

Scientific objectives pertinent to potential Mars Scout missions will also be considered. More information on potential Mars Scout missions can be found at URL http://spacescience.nasa.gov/an/marsscoutsworkshop/.

1.3 *In situ* Investigations

This solicitation pertains only to instruments/systems that would be deployed on the surface or subsurface of Mars. Orbital instruments may be the subject of a future MIDP solicitation. The following list of measurements and instruments are given as a guide only and not in any priority order, and other instruments that fulfill the science objectives listed above are permissible and encouraged:

- Investigations of surface materials that include, but are not limited to, gas chromatography experiments, mass spectrometers, amino acid detectors, and Raman spectrometers;
- Environmental measurements, including atmospheric temperature, pressure, density, and humidity; wind velocity; and surface temperature; dust loading; solar and thermal fluxes;
- Weather phenomena monitoring including long-duration water vapor flux and atmospheric isotopic distribution;
- Characterization of subsurface ice and water, the techniques for which may include microwave probes, magnetic resonance sensors, resistivity experiments, or other geophysical methods;
- Subsurface sounding, which may include low and high frequency ground penetrating radar and/or electromagnetic sounding;
- High-resolution imaging from a lander or rover, which may include stereo imaging systems, multi-spectral cameras, and hyperspectral imaging spectrometers;
- High-resolution microscopy from a lander or rover, especially in the submicron range, including instrument systems that incorporate autonomous detection of biostructures in rock, and rock abrasion devices (up to 10 cm deep);
- Heat flow calibration below the annual seasonal wave, and seismic activity monitoring;
- Surface soil and rock bulk composition and mineralogy, which includes, but is not limited to, point spectrometers, alpha-proton x-ray spectrometers or x-ray diffraction (XRD) instruments, thermal evolved gas sensors, mass spectrometers, Raman spectrometers, and Mossbauer spectrometers;
- Organic molecule detection, oxidation boundary determination, and mineralogical assessment from an *in situ* drilling platform (particularly encouraged); and
- Remote elemental analysis methods such as Laser Induced Breakdown Spectroscopy (LIBS), or other approaches that do not require contact to sense the materials in question.

1.4 Sample Acquisition and Handling Investigations

The ability to acquire and deliver surface and subsurface samples to scientific instruments on the primary payload is of particular importance for missions in the 2007 to 2011 time frame (MSL, Mars Scouts, and MSR). Proposals that provide for sample acquisition and handling mechanisms or instrument suites that can perform one or more of the following tasks are encouraged:

- Acquire a 1 cm^3 sample of surface soil or rock from a lander or rover platform;
- Acquire a 1 cm^3 sample of subsurface material from a borehole with maximum depth of 15 m and a maximum diameter of 7 cm (may be designed as part of a drilling package);
- Deploy instruments or instrument sensing heads within a borehole (as defined in the second objective above) to permit measurement-while-drilling or measurement-after-drilling data collection;
- Deliver a 1 cm^3 sample of soil or rock from the sample acquisition mechanism (drill, sampling arm, core drill, etc.) to a series of instruments on board the lander or rover platform for analysis;
- Create a smooth measurement surface for XRD and other analysis techniques; and/or
- Volatilize a sample for mass spectrometry and other analysis techniques.

2.0 Programmatic Information

The instruments to be developed under this program may be tested using the NASA Jet Propulsion Laboratory rover platforms such as the FIDO surface lander and Landed Mobile Laboratory (LML) testbeds or other testbeds identified and provided by the proposer. When utilizing NASA-provided testbeds, accommodation of instruments with the field tests and the funding of these tests will be arranged by the MIDP Project Manager as each one reaches the appropriate level of readiness.

It is planned that this iteration of the MIDP solicitation will be funded at a level of $5.0M per year for up to three years. Based on this funding level and the submission of proposals of appropriate merit, it is anticipated that 10-15 selections will be made. . This solicitation is the second of an ongoing sequence of MIDP solicitations. It is expected that these solicitations will be issued biannually, with their focus dependent upon current NASA MEP mission requirements and goals. In all cases, however, continued funding of multiyear projects will be contingent upon the availability of funds and annual assessment of performance and relevance of the research effort to mission and program requirements.

IMPORTANT INFORMATION

- As discussed in the *Summary of Solicitation* of this NRA, the Office of Space Science (OSS) now uses a unified set of instructions for the preparation and submission of proposals given in the document entitled *NASA Guidebook for Proposers Responding to NASA Research Announcement - 2003* (or *NASA Guidebook for Proposers* for short) that may be accessed by opening http://research.hq.nasa.gov/ and linking through "Helpful References," or by direct access at http://www.hq.nasa.gov/office/procurement/nraguidebook/ (note that the updated 2003-edition of the *Guidebook* is used for this solicitation).
- Section 6 of this NRA's *Summary of Solicitation* contains the Web address relevant to the electronic submission of a Notice of Intent (NOI) to propose and a proposal's *Cover Page/Proposal Summary/Budget Summary*, as well as the mailing address for the submission of the hard copies of a proposal.

Selections for this MIDP solicitation will be made by the Director of the Mars Exploration Program in the Office of Space Science. Questions concerning this program element may be directed to the MIDP Program Officer:

Mr. David B. Lavery
Mars Exploration Program
Code SM
Office of Space Science
NASA Headquarters
Washington, DC 20546-0001
Telephone: (202) 358-4684
Facsimile: (202) 358-3097
E- mail: David.B.Lavery@nasa.gov